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(54) Brush seal for Turbo-Engines

(57) A brush seal for turbo-engines is provided for sealing off spaces (R1, R2) subjected, in use, to different pressures at a peripheral gap, particularly between an engine stator (1,101) and an engine rotor (2,102), a mounting (3,103) on the engine stator (1,101) for a bundle of bristles (B), which extends from a mounting (3,103) between peripheral webs (4,5; 104, 105) so as to seal off the rotor (2,102) axially and form an axial gap in the peripheral direction with the web (5,105) facing the high-pressure side. The bundle of bristles (B) is provided with means for screening (6) or breaking up (107) turbulent flow initiated by the engine rotor (2,102), at least on the side facing the space (R1) of higher pressure (P1) at the seal. The means of screening may be having the bristles adjacent the high pressure side of a greater diameter than the other bristles, or a wire mesh may be adjacent the bristles on the high pressure side. The means for breaking up the turbulent flow may be a porous block or a block with passageways therein that may be horizontal or vertical.

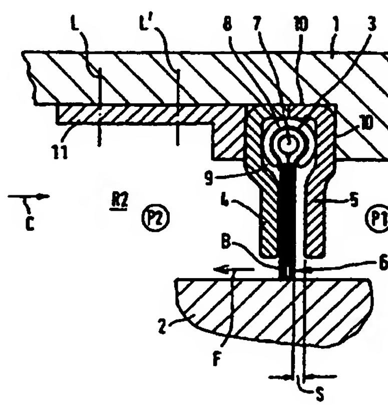

FIG.1

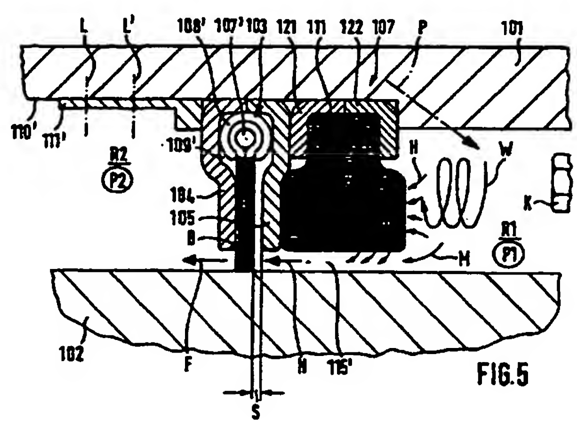

FIG.5

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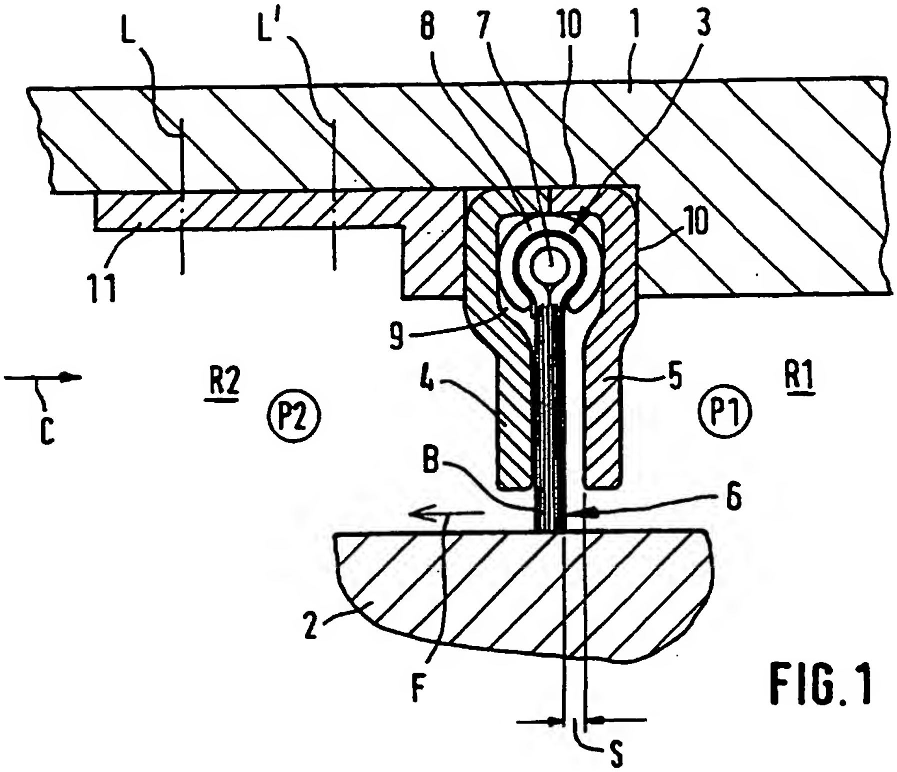

FIG.1

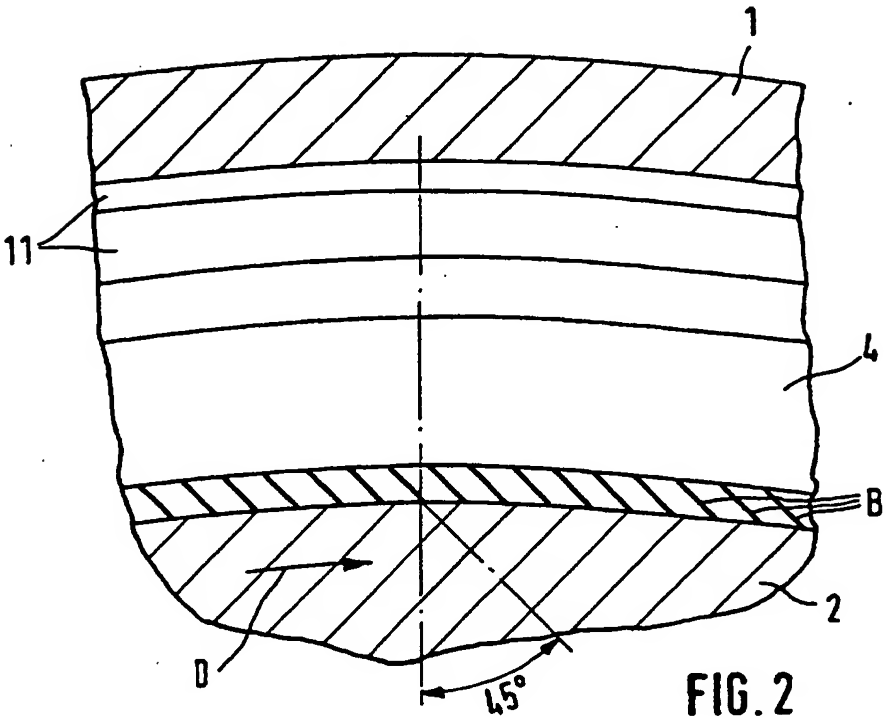

FIG.2

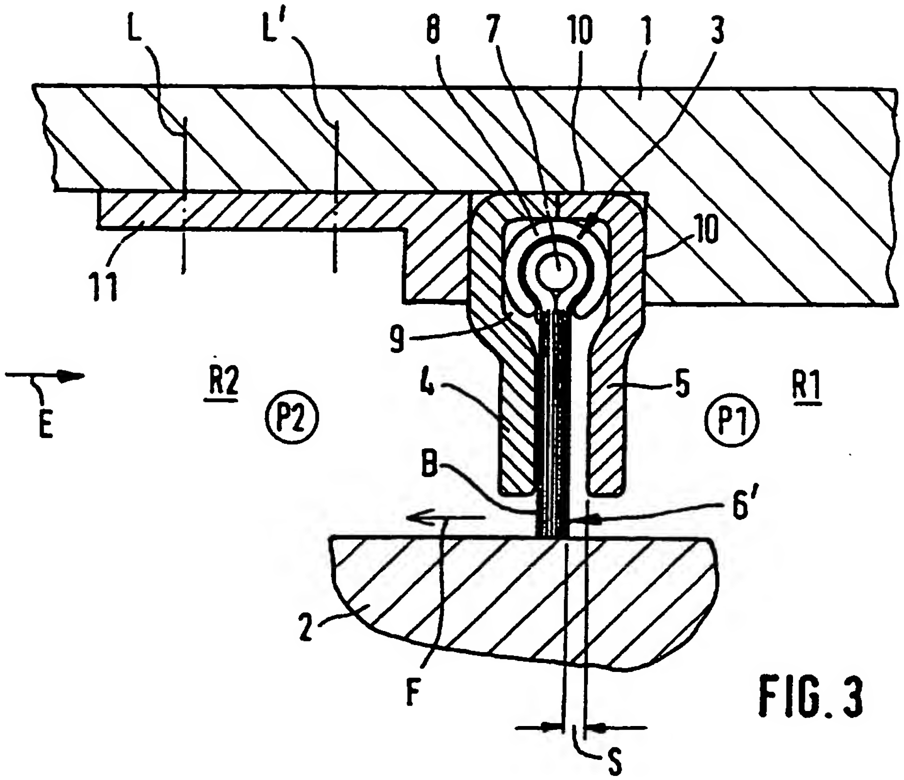

FIG. 3

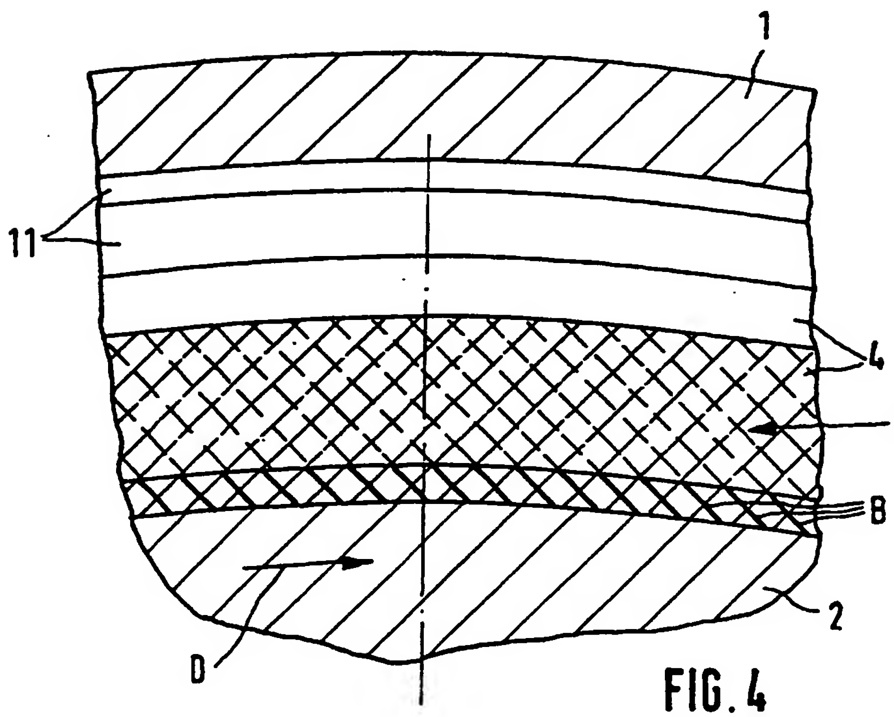

FIG. 4

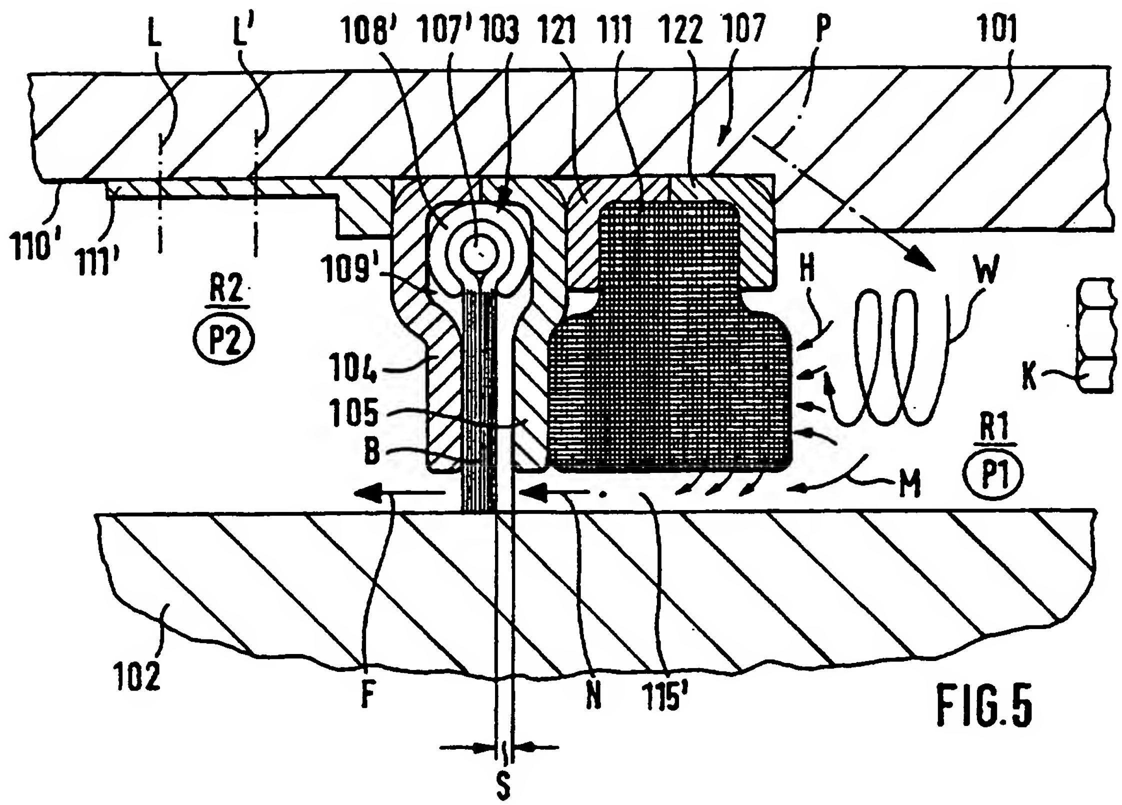
L
L'
108'
107'
103
121
111
122
107
P
101
110'
111'
109'
R2
P2
104
105
B
H
W
K
R1
P1
M
102
F
N
115'
S

FIG.5

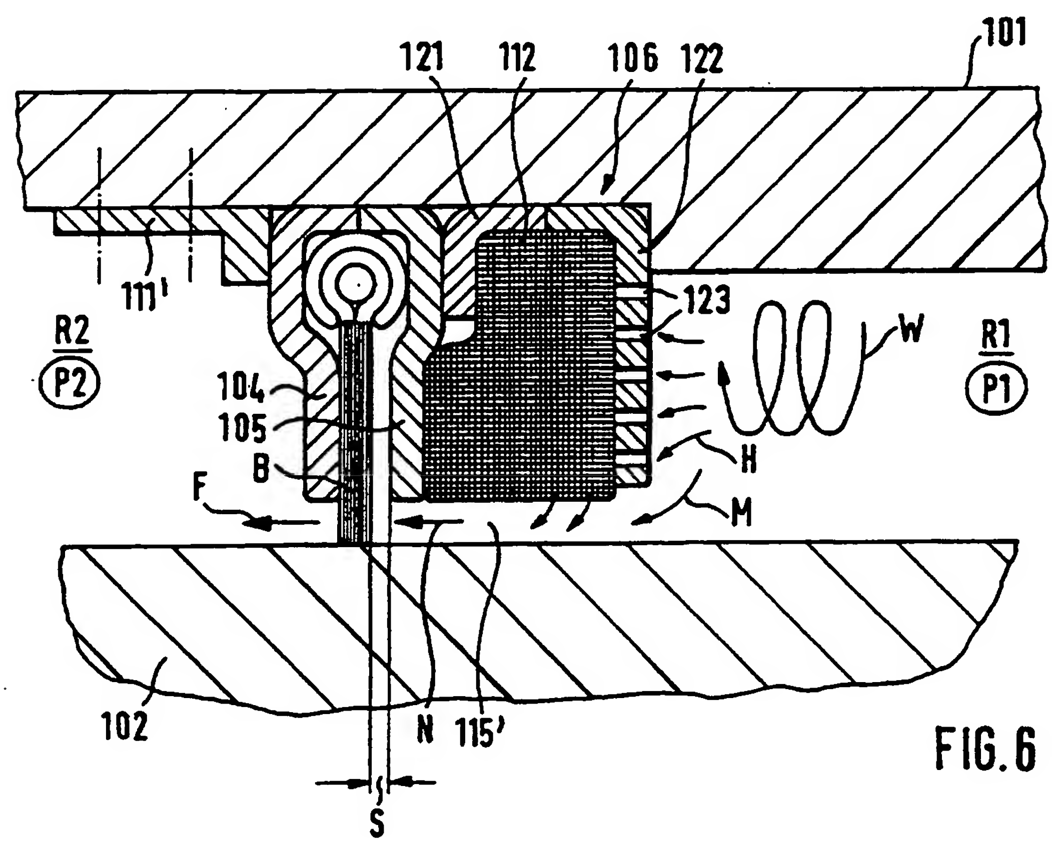
121
112
106
122
101
111'
123
R2
P2
W
R1
P1
104
105
B
F
H
M
102
N
115'
S

FIG.6

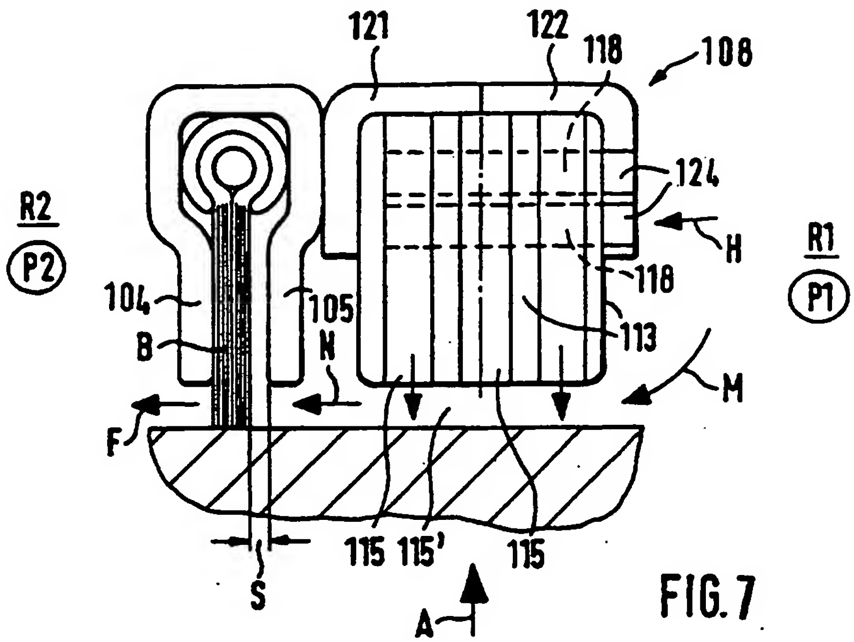
121
122
118
108
124
H
118
R1
P1
R2
P2
104
105
113
B
N
M
F
115
115'
115
S
A

FIG. 7

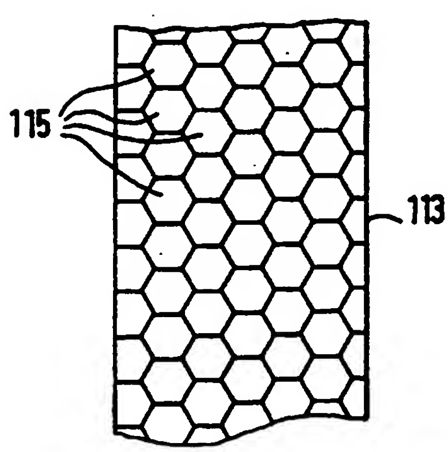
115
113

FIG. 8

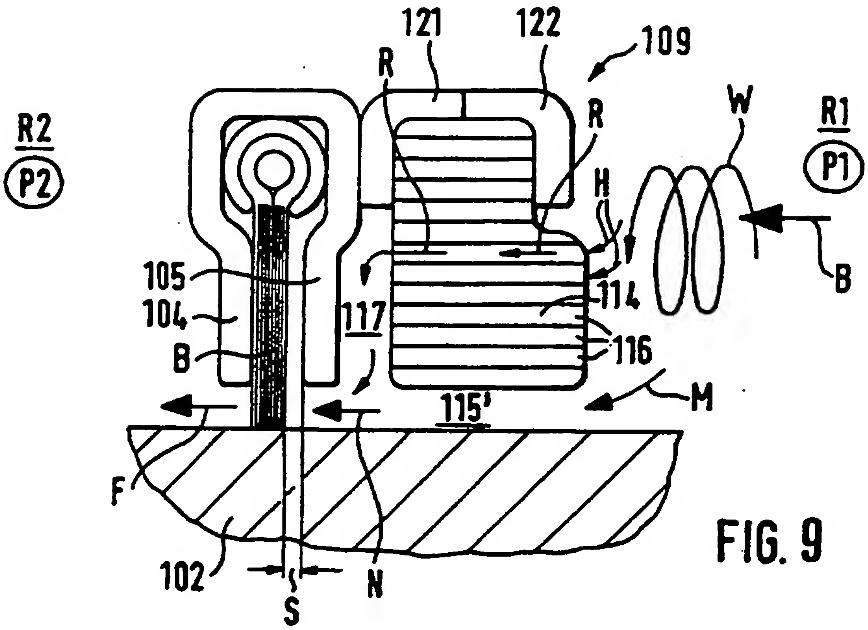
121
122
109
R
R
W
R1
P1
R2
P2
H
B
105
104
B
117
114
116
M
115'
F
102
S
N

FIG. 9

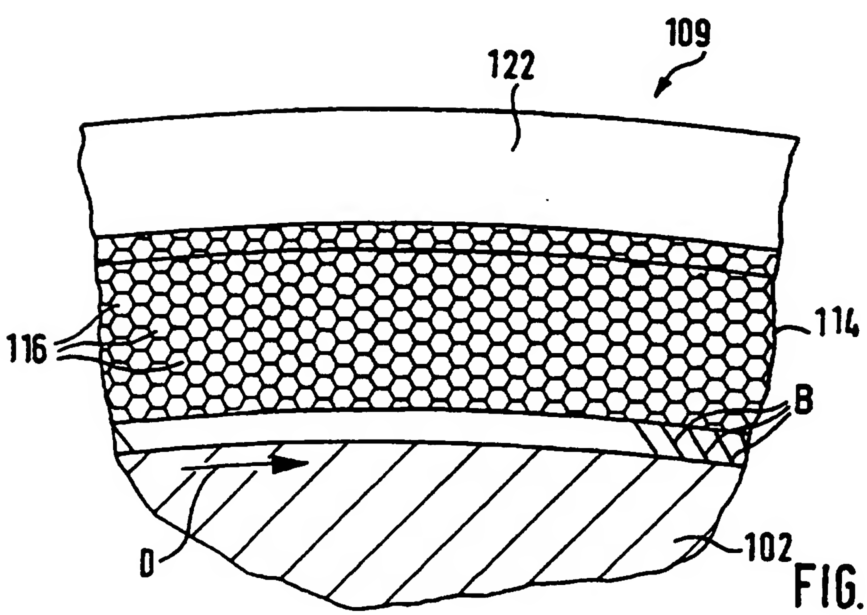
109
122
116
114
B
D
102

FIG. 10

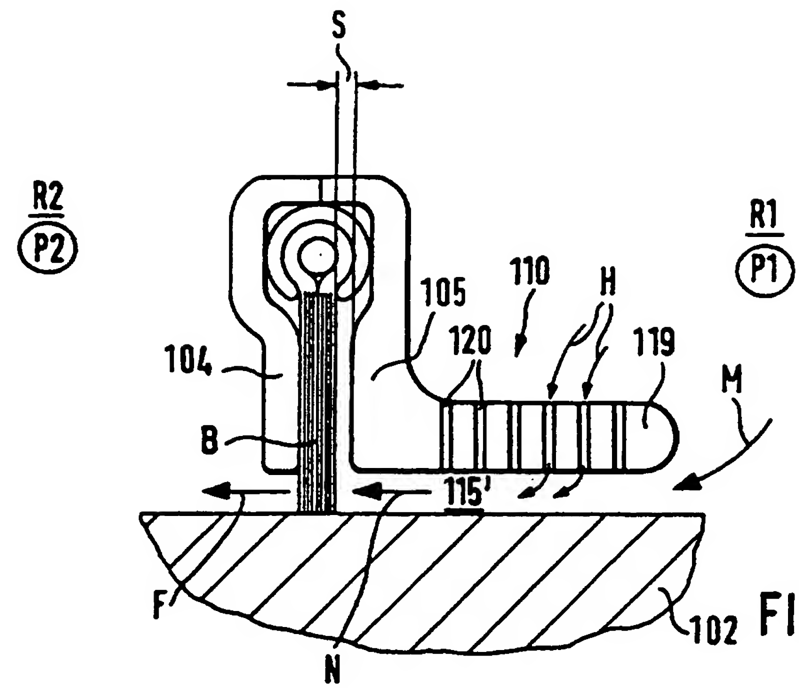
S
R2
P2
R1
P1
105
110
H
104
120
119
M
B
115'
F
N
102

FIG.11

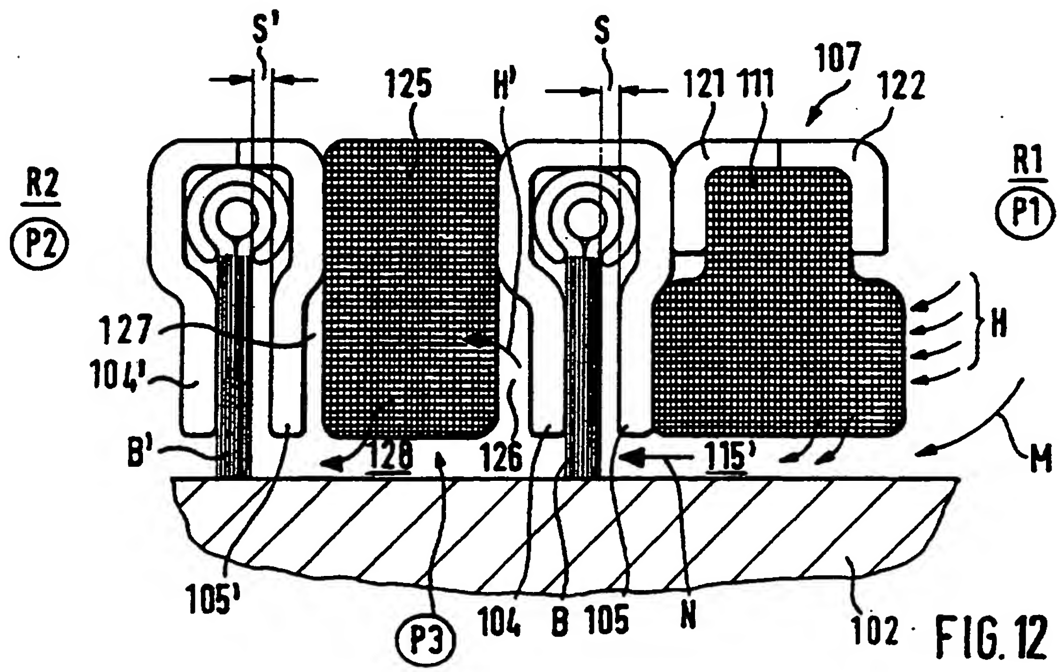
S'
125
H'
S
121
111
107
122
R2
P2
R1
P1
127
104'
H
B'
128
126
115'
M
105'
P3
104
B
105
N
102

FIG.12

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Brush seal for turbo-engines

The present invention relates to a brush seal for turbo-engines for sealing off spaces at a peripheral gap between a stator and a rotor subjected, in use, to different pressures, wherein a bundle of bristles extends from a mounting on the stator between peripheral webs so as to seal off the rotor axially and form an axial gap in the peripheral direction with the web on the high-pressure side of the seal.

Brush seals of the known type described (DE 39 07 614 A1) are used in turbo-engines, in particular in gas-turbine engines, in order to seal off spaces from one another subjected to different hydraulic pressures at peripheral gaps, for example between an engine housing and the rotor or an engine shaft, with as little leakage as possible. In this case it should be possible to compensate eccentric positions of the rotor or shaft relative to the housing – resulting for example from imbalances of the rotor –by a resilient and movable guidance of the bristles.

A serious drawback of such brush seals and also of other known brush seals is that, as a result of the rotation of the shaft, the bristles of the brush seal are subjected to a rotating turbulent flow, which adversely affects the shape and the desired geometrical arrangement of the brush and thus the sealing effect. The turbulent flow has a particularly adverse effect upon the local position of the free ends of the bristles which project opposite the ends of guiding webs in the direction of the surface of the rotor or shaft. A reliable, low-leakage primary seal is therefore not possible. The turbulent flow and the disadvantageous consequences thereof cannot be eliminated on the low-pressure side of the seal either. Furthermore, the occurrence of individual and particularly pronounced types and geometries of turbulence can be additionally encouraged by special surface geometries and structures of the shaft (helices, corrugations, steps).

An object of the invention is to provide a brush seal of the type initially described, which, for the purpose of optimum sealing, ensures that the shape and geometry of the bristles are maintained with respect to a rotating turbulent flow or formation of turbulence caused by the shaft.

The invention provides a brush seal as claimed in Claim 1.

According to the invention, in a first embodiment screening means are advantageously a component of the wound bundle or pack of bristles. The screening device forms a device which effectively stabilizes and protects the bundle of bristles from a rotating turbulent flow. In this case the bristles of a bundle of bristles are guided over the greater part of their longitudinal extension between the axially spaced webs and are screened from the local pressure spaces. Further preferred embodiments relating to the brush seal produced with the screening means are set out in the features of Claims 2 to 8.

In accordance with a modification of the invention, the screening means may be formed by at least one layer or row of bristles of relatively large bristle or filament thickness of the bundle of bristles. The greatest thickness of bristles should be such that the necessary resilience of deformation is still provided by even these thick bristles *inter alia*, in order to ensure optimum sealing.

The axial gap, one flank of which can be formed by respective screening means, may be formed with a smaller width and may be made having substantially 1/10 of the maximum width of the bundle of bristles. This axial gap prevents the bristles from being squeezed in locally between the two webs and ensures the necessary minimum clearance of the bristles in the peripheral and axial directions. In addition, by means of the axial gap it is possible to achieve a substantially uniform distribution of fluid pressure at the periphery at the screening means and at other bristle components of the bundle adjacent thereto on the inside.

An increased overall stability with respect to a turbulent flow possibly occurring

even on the low-pressure side is achieved according to Claim 5.

The sealing effect and the overall stability of the bundle of bristles – as well as existing screening means – may be improved by additionally designing the bundle with the filament or bristle thickness alternating in layers or rows (Claim 8).

The above remarks also apply in combination with screening means constructed as a wire mesh (Claim 6). The screening means may comprise fine wires soldered cross-wise or interwoven one under the other. A rotating air vortex can be damped or largely neutralized for example by way of the loops of the wire mesh. If this "screening device" is arranged on the high- and low-pressure sides, the bristles are held together axially in the manner of a cage, so that even axial deviations of the bristles, in particular at the end of the brush projecting radially from the webs, can be restricted. The wire mesh is made annular and is held with clearance with respect to the rotor or the shaft by a central bore.

By virtue of an alternative embodiment of the brush seal according to the invention with a device for breaking up the turbulent flow, a rotating turbulent flow produced by the rotating rotor in the space of higher pressure in front of the seal means can be very largely broken up and can be essentially dissipated with respect to its original energy content. A considerable part of now relatively calmed fluid thus flows away from the turbulent flow into the axial annular duct in front of the seal (bundle of bristles), the flow velocity of the fluid, for example air, being increased in the said duct, at the same time as a drop in pressure occurs in the axial annular duct relative to the higher pressure level present in the space or annular space in front of the means. The axial annular duct represents an additional "calming path" for the fluid flowing away towards the bundle of bristles out of the space of higher pressure. A remaining portion of the rotating turbulent flow flows away laterally into the means in order to calm or break up the turbulence in the manner described, and flows away essentially in the radial direction into axial annular gap along the peripheral face of the means radially on the inside. Further advantageous embodiments relating to the brush seal produced with the device for breaking up the turbulent flow are set out in the features of Claims 9 to 19.

According to Claim 9 the device can advantageously be an annular member made permeable by ducts.

According to the invention the bristles of a bundle of bristles extend over the greater part of their longitudinal extension between the axially spaced webs and are screened from the pressure spaces. The axial gap may be formed with a smaller width and may be made with substantially a tenth of the maximum width of the bundle of bristles. This axial gap prevents the bristles from being squeezed in locally between the two webs and it ensures the necessary minimum clearance of the bristles in the peripheral and axial directions. In addition, by means of the axial gap it is possible to achieve a substantially uniform distribution of fluid pressure on the peripheral side of the bundle of bristles arranged upstream.

An advantageous device resulting from the combination of Claims 9 and 10 comprises a metallic sponge, the porous structure of which may be adapted to the dissipation of the turbulence as well as to the guidance of the fluid through the annular member in the direction of the axial annular duct. The sponge may be produced from a light-weight metallic material, for example a titanium aluminide with a globular cell structure. It may alternatively be produced in several sintering stages in the manner of hollow spheres from an intermetallic compound or alloys thereof. Because of the hollow-sphere structure the porosity or a corresponding duct system can be taken into consideration during the production.

According to the alternative of Claim 10 the means may be an annular member designed in the manner of a honeycomb, it being possible for radial ducts (Claim 11) or axial ducts (Claim 12) or combined axial and radial ducts and ducts locally connected to one another hydraulically to be formed by the honeycomb structure or to be integrated therein (Claim 8). According to Claim 13 the axial ducts at the ends remote from the high-pressure side may open into a peripheral gap which is connected to the axial annular duct.

An increased sealing effect can be achieved in the case of a multiple-stage pressure

seal according to Claim 18, in particular when using a further metallic sponge for the means. In this way, any residual turbulence still remaining in the flow downstream of the first seal can in any case be completely eliminated in front of the second seal.

Embodiments of the invention are now described with reference to the accompanying drawings, in which:

Fig. 1 is an axial section through the brush seal with portions of the engine stator and rotor cut away, and with the screening device along one bristle flank of the axial gap on the high-pressure side, the screening device being formed by layers of bristles of relatively large filament thickness,

Fig. 2 is a view in the direction C in Fig. 1,

Fig. 3 is an alternative axial section in accordance with Fig. 1, in which, however, the screening device along the bristle flank of the axial gap on the high-pressure side is formed by a wire mesh on the bundle of bristles,

Fig. 4 is a view as seen in the direction E in Fig. 3, in which the wire mesh is illustrated by intersecting lines,

Fig. 5 is an axial section through the brush seal in correlation with the engine stator and rotor shown cut away in each case, and with the means provided upstream of the brush seal, in this case as a metallic sponge for breaking up the turbulent flow,

Fig. 6 is an axial section through the brush seal with a corresponding correlation of the engine stator and rotor designed in principle in accordance with Fig. 5, with the means as a metallic sponge with a relatively low degree of porosity and with axial bores in the right-hand cover part,

Fig. 7 is an axial section, shown omitting the engine stator, of modified means constructed upstream of the brush seal as an annular member with a honeycomb-like structure and provided with radial and axial ducts,

Fig. 8 is a view in the direction A of Fig. 7, omitting the rotor,

Fig. 9 is an axial section, shown omitting the engine stator, of an embodiment of the

means upstream of the brush seal as an annular member with a honeycomb-like structure, but in this case illustrated with axial through ducts,

Fig. 10 is a view in the direction **B** of Fig. 9, which shows the setting angle of the bristles which is uniform over the periphery and inclined in the direction of rotation of the engine rotor,

Fig. 11 is an axial section, omitting the engine stator, of the brush seal with an embodiment of the means upstream of the seal as an axial annular flange on a web and with radial ducts in the annular flange connecting the space of higher pressure to the axial annular duct, and

Fig. 12 shows, omitting the engine housing, a multiple-stage pressure seal illustrated in axial section and constructed as a brush seal with an additional metallic sponge between two individual, axially-spaced brush seals.

Figs. 1 and 2 of a first embodiment and Fig. 5 of a second embodiment show a brush seal for a turbo-engine. The brush seal is intended to seal off a peripheral gap from spaces **R1, R2** subjected to different hydraulic pressures between an engine stator and housing 1, 101 and the surface of an engine rotor 2, 102 mounted rotatably in the housing in a coaxial manner. In this case the existing fluid pressure **P1** in the space **R1** is higher than the fluid pressure **P2** in the space **R2**. The primary leakage at the seal is designated by the arrow **F**. A mounting 3, 103 is provided on the engine stator 1, 101 for a bundle of bristles **B**. The bundle of bristles **B** extends from the mounting 3, 103 in a sealed manner to against the rotor surface between substantially parallel webs 4, 104; 5, 105 orientated at right angles to the rotor surface. On the side facing the space **R2** of lower pressure **P2** the bundle of bristles **B** touches one respective inner face of the web 4, 104. On the other side facing the space **R1** of higher pressure **P1** the bundle of bristles **B** forms an axial gap **S** in the peripheral direction opposite the inner face of the web 5, 105.

Fig. 2 shows the bristles of the bundle **B** (here shown merely diagrammatically) with relatively large peripheral intervals, in which case the bristles are each set obliquely at an angle of 45° in a uniform manner over the periphery in the direction of rotation **D** of the

engine rotor 2 and touch the rotor surface.

As shown in Figs. 1 and 5, the bundles of bristles **B** are arranged in the mounting 3, 103 and are gripped between a clamping tube 8, 108 and a central portion of the bundle of bristles **B** is bent over substantially in a U-shape around a core ring 7, 107. The clamping tube 8, 108 has a peripheral slot for the bundle of bristles **B**; the clamping tube 8, 108 fits securely radially inside an annular space 9, 109 which is open on one side and which is formed by two housing parts comprising the peripheral webs 4, 104; 5, 105. The two housing parts together with the webs 4, 104, 5, 105 are clamped and held in a peripheral groove; the groove is formed by a stepped enlargement 10, 110 in the engine housing 1, 101 on a larger internal diameter, and by the axial end face of an annular component 11, 111 screwed to the engine housing 1, 101 along the lines **L, L'**.

All the bristles of the bundle of bristles **B** can be produced from a ceramic material, in particular silicon carbide. Alternatively, it is possible to use high-alloy metallic bristle materials. Such materials may be used in a similar manner in all the embodiments of the invention.

As shown in Figs. 1 and 2, screening device 6 forms one flank of the axial gap **S** on the bundle of bristles **B**. The screening device 6 is in the form of at least two bristles arranged axially in succession in rows or layers and having a relatively large diameter compared with the other bristles produced with relatively small diameters on the bundle of bristles **B**.

The screening device 6 is arranged together with the bundle of bristles **B** in the mounting 3; in this case the screening device is gripped between a clamping tube 8 and a portion of the bundle of bristles **B** bent over substantially in a U-shape around a core ring 7.

The embodiment of Figs. 3 and 4 is identical to the embodiment of Figs. 1 and 2 except that one flank of the axial gap S formed by the bundle of bristles **B** on the high-pressure side has a screening device 6' constructed as a wire mesh. The fastening of the

bristles **B** by way of the mounting 3 is practically identical to those according to Fig. 1. As viewed in the direction **E** in Fig. 3, the wire mesh forming the screening device 6' is indicated in Fig. 4 by the crossed layer of the wires and is shown radially between the bundle of bristles **B** and the web 4.

The invention may also be in the form of a stepped pressure seal with at least two brush seals arranged axially spaced with respect to the rotor and having respective bundles of bristles **B** as shown in Figs. 1 and 2, and Figs. 2 and 3, respectively.

In the second embodiment according to Figs. 5 to 12 a device 107 is arranged upstream of the brush seal in order to break up a turbulent flow **W** caused by the engine rotor 102.

In principle, the device 107 according to Fig. 5 comprises an annular member 111 which is structured so as to be traversable by the flow and which, together with the end of one web 105, forms an axial annular duct 115' opposite the rotor surface, the annular duct 115' being connected to the axial gap **S** upstream of the bristles. In addition, the annular member 111 illustrated in Fig. 5 is constructed in principle as a metallic sponge which has a relatively low degree of porosity. In principle, operation is as follows:

Air is supplied under pressure to the annular space **R1** upstream of the device as shown by the direction of the arrow **P** in the oblique position indicated. The gap flow as shown by the arrow N would normally be intensely swirled, in particular as the result of an arrangement of a rotary swirl **W** caused by peripheral screw heads **K**, in such a way that a correct position of the bristles of the bundle **B** would no longer be possible. According to the invention, portions now flow away out of the region of the rotary turbulence **W** laterally forward into the annular member 111 in accordance with the arrows **H** and then flow away over the inner peripheral face of the annular member 111 into the axial annular duct 115' in accordance with the direction of the arrows. The substantial portion of the fluid flows axially forward out of the region of the rotary turbulence **W** already calmed in principle into the axial annular duct 115' in accordance with the arrow **M**. A further calming

of the sealing fluid flow takes place inside the axial annular duct 115', so that the flow is calmed upstream of the bristles of the brush seal in accordance with the arrow N; the screw heads K mentioned above are connected to the engine rotor 102 in a rotationally fixed manner.

Like Fig. 5, Fig. 6 also shows that the annular member 112 constructed in the form of a metallic sponge is surrounded at least in part by two parts 121, 122 of a casing. As shown in Fig. 6, one part 122 of the casing is provided with axial through openings 123 along the end face of the said annular member 112 on the high-pressure side. The axial through openings 123 are attached locally to the internal structure of the porous annular member 112 traversable by the flow. In addition, the annular member 112 shown in Fig. 6 differs from the annular member 111 of Fig. 5 by a comparatively lower degree of porosity. In addition, the basic operation described above in conjunction with Fig. 5 with respect to the occurrence of the rotary swirl W and its disintegration are similarly also practicable for the embodiment according to Fig. 6.

As shown in Figs. 7 and 8, the annular member 113 of the device comprises a duct structure designed in the manner of a honeycomb having radial ducts 115 and possibly axial ducts 118 provided by way of assistance. In the example of Figs. 7 and 8, therefore, the annular member 113 is provided with axial and radial ducts 118, 115 which are interconnected hydraulically in positions at an angle with respect to one another. The radial ducts 115 open on one side into the axial annular duct 115' and the axial ducts 118 are connected on one side to the space R1 of higher fluid pressure P1. In order to eliminate the harmful rotary turbulence W, the device with the annular member 113 according to Figs. 7 and 8 is practically identical in this respect to the device according to Figs. 5 and 6.

In the case of the device 109 according to Figs. 9 and 10, an annular member 114 designed in the manner of a honeycomb is likewise provided, but in this case it is traversed exclusively by axial ducts 116 from right to left. Portions of the rotary turbulence W thus flow in the axial direction through the axial ducts 116 as shown by the arrows R in Fig. 9,

and the axial ducts 116 terminate in a peripheral gap 117 on the low-pressure side of the annular member 114. The peripheral gap 117 is formed between a face of the annular member 114 on the low-pressure side and a web 105 arranged upstream of the bundle of bristles **B**. On the side facing the rotor 102 the peripheral gap 117 is connected to the axial annular duct 115' extending along the rotor surface.

The formation of the ducts in the manner of a honeycomb as shown in Figs. 7 to 10 has the additional advantage that a desired edge diffraction of the turbulent-air flow **W** taken up by the respective devices is achieved over the polygonal duct structures.

Fig. 11 shows a device 110 which is constructed integrally at least together with one web 105. As shown in Fig. 11, a web 105 of the brush seal is extended axially upstream in the manner of an annular flange 119. The annular flange 119 is situated at a radial distance from the rotor surface and thus likewise forms a radial annular duct 115' along the rotor surface. In this case the axial annular duct 115' is connected to the axial gap **S** upstream of the bristles of the bundle **B**. In addition, the annular flange is provided with radial through bores 120 distributed over the periphery. In this embodiment too, the rotary turbulence **W** already mentioned above is very largely eliminated or broken up, as portions flow off from the rotating turbulent flow in accordance with the direction of the arrows **H** into the axial annular gap 115' by way of the radial bores 120.

Fig. 12 shows a multiple-stage pressure seal with two bundles of bristles **B**, **B'** held axially spaced on the engine stator 101. A further annular member 125, which in this case is constructed for example in the form of a metallic sponge, is arranged between two axially-spaced, facing housing parts , ie the webs 104, 105' of the first and second seals. Peripheral gaps 126, 127, which open into a further axial annular duct 128, are left between the two axial end faces of the further metallic sponge 125 and the webs 104, 105' for the bristles of the first and second seals. The further axial annular duct 128 forms a further pressure space axially between the respective ends of the two bundles of bristles **B**, **B'**. In addition, as shown in Fig. 12, the radial widths of the gaps of the axial ducts 115' and 128 are identical.

The invention may preferably be used in gas-turbine engines.

Claims:

1. A brush seal for turbo-engines for sealing off spaces at a peripheral gap between a stator and a rotor subjected, in use, to different pressures, wherein a bundle of bristles extends from a mounting on the stator between peripheral webs so as to seal off the rotor axially and form an axial gap in the peripheral direction with the web on the high-pressure side of the seal, means being provided at least on the upstream side of the bundle of bristles for screening or for breaking up turbulent flow initiated by the engine rotor.

2. A brush seal according to Claim 1, wherein the screening means are formed by at least one peripheral layer of bristles having the largest bristle thickness of the bundle of bristles.

3. A brush seal according to Claim 1 or 2, wherein the means for screening form one flank of the axial gap of the bundle of bristles.

4. A brush seal according to Claim 3, wherein the bundle of bristles is provided in layers or rows with a bristle or filament thickness increasing in the direction of one flank of the axial gap.

5. A brush seal according to any one of Claims 1 to 3, wherein the bundle of bristles is provided with the screening means on the side facing the space of higher pressure and on the side facing the space of lower pressure.

6. A brush seal according to any one of Claims 1, 3 or 5, wherein the screening means are formed by a wire mesh held on the bundle of bristles.

7. A brush seal according to any one of Claims 1 to 6, wherein the screening means together with the bundle of bristles are arranged on the mounting and are gripped between a portion of the bundle of bristles bent over substantially into a U-shape

about a core ring, and a clamping tube provided with a peripheral slot and mounted radially on the inside in an annular space open on one side and formed by two housing parts comprising the peripheral webs.

8. A brush seal according to any one or more of Claims 1 to 3 and 5 to 7, wherein the rest of the bundle of bristles comprising the screening means is formed in rows or layers by bristles of different bristle or filament thickness.

9. A brush seal according to Claim 1, wherein the means are formed by an annular member open substantially on one side to the fluid in the space of higher pressure and at least partially traversable, in use, by fluid flow and together with the end of one web forming an axial annular duct along the rotor surface, the annular duct being connected to the axial gap upstream of the bristles.

10. A brush seal according to Claim 9, wherein the annular member is constructed in the form of a metallic sponge or in the manner of a honeycomb.

11. A brush seal according to Claim 10, wherein the annular member is provided with radial ducts formed by the honeycomb structure.

12. A brush seal according to Claim 10, wherein the annular member is traversed by axial ducts contained in the honeycomb structure.

13. A brush seal according to Claim 9 or 12, wherein the ducts on one side of the annular member open into a peripheral gap formed between one side of the annular member and one web arranged upstream of the bundle of bristles the peripheral gap being connected to the axial annular duct extending along the rotor surface.

14. A brush seal according to any one or more of Claims 1, 9 and 10, wherein the annular member is provided with axial and radial ducts interconnected hydraulically in positions at an angle with respect to one another, the radial ducts opening at one

end thereof into the axial annular duct and the axial ducts being connected to the high fluid pressure space.

15. A brush seal according to any one of Claims 1, 9 to 14, wherein the means are constructed integrally at least together with one web arranged upstream of the bundle of bristles.

16. A brush seal according to Claim 15, wherein one web of the brush seal is extended axially upstream in the manner of an annular flange forming an axial annular duct at a distance radially from the rotor surface, the annular duct being connected to the axial gap upstream of the bristles and being provided with radial through bores distributed over the periphery thereof.

17. A brush seal according to any one of Claims 9, 10, 12, 14, wherein the annular member is surrounded on the outside and along the two axial end faces at least in part by a two-part casing and is held therein, one part of the casing being provided with axial through openings along the end face of the annular member on the high-pressure side, the through openings being attached locally to the internal structure traversable by the flow or directly to the inside ends of the axial ducts.

18. A brush seal according to any one of Claims 1, 9, 10, wherein there is a multiple-stage pressure seal with two bundles of bristles held axially spaced on the stator, a further annular member being arranged between two axially-spaced housing parts having the webs of the first and second seals.

19. A brush seal according to Claim 18, wherein peripheral gaps opening into a further axial annular duct are left between the two axial end faces of the further annular member and webs for the bristles of the first and second seals, the axial annular duct forming a further pressure space axially between the ends of the two bundles of bristles.

20. A brush seal according to Claim 19 or 20, wherein the further annular member is a metallic sponge.

21. A brush seal substantially as herein described with reference to any of the embodiments shown in the accompanying drawings.

The Patent Office

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Claims searched:	1-21	**Date of search:**	12 September 1996

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Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): F2B

Int Cl (Ed.6): F16J 15/32

Other: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2,281,108 A	Rolls-Royce plc	1 and 3
X	WO 92/14951 A1	Cross Manufacturing Company Limited	1,4 and 5
X	US 5,318,309	Wu-Yang Tseng et al	1

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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